Claims:

1. A system for high speed and precision measurement of the distance between at least two near contact surfaces, one of which is an optically transparent element and the other is a substantially non-transparent element using heterodyne interferometry, comprising:

a laser source, which produces an output having two superimposed orthogonally polarized beams having S and P polarization, with a frequency difference between them;

means for splitting the polarized beams into measurement and reference beams without altering the characteristics of the polarized beams;

means for causing the reference beams to interfere;

a reference photo detector for detecting the reference beams and providing a reference signal;

means for causing the measurement beam to strike the object of interest at an oblique angle after passing through a glass plate having a polarization coating on the bottom surface close to the object of interest, the oblique angle is such that the S polarization of the incident beam is reflected from the bottom surface of the polarization coated glass plate and the P polarization refracts through the glass plate, the P polarization reflects from the substantially non-transparent object of interest and refracts to the glass plate;

means for causing the reflected S and P polarization beams from the bottom surface of the glass plate and the surface of the object respectively to interfere;

a measurement photo detector for detecting the measurement beams and providing a measurement signal; and

means for determining the distance between the bottom surface of the glass disk and the object surface based on the phase deference between the measurement and reference signals from the measurement and reference photo detectors.

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2. A system according to claim 1, wherein the laser source which produces two superimposed orthogonally polarized beams having a frequency difference between them includes a Zeeman laser source.

3. A system according to claim 1, wherein the laser source which produces two superimposed orthogonally polarized beams having a frequency difference between them includes an acousto optic modulator to produce two orthogonally polarized beams of a frequency difference equal to the center frequency or carrier frequency of the acoustic wave in the acousto optic modulator, and combining the orthogonally polarized beams from the acousto optic modulator having a frequency difference by using optical components.

4. A system according to claim 1 which further includes means for scanning the output of the laser source in both X and Y axes using an acousto optic deflector, wherein the two superimposed orthogonally polarized beams from the laser source enter the acoustic crystal of acoustic optic deflector at Bragg's angle which produces a first order scanning beam and a zero order beam, both containing the two orthogonally polarized beams.

5. A system according to claim 4 which further includes means for spatially filtering and expanding the laser output using a spatial filter including focusing optics and a pin hole depending on the beam expansion ratio and the quality of the required beam.

6. A system according to claim 4 which further includes means for focusing the scanning beam on a flat plane by using a lens.

7. A system according to claim 6 which further includes means for scanning beams parallel to one another and for focusing the beams on a flat plane at a predetermined distance, and means for positioning a scanning lens in the reflected beam path at a distance equal to the back working distance of the scanning lens from the object surface; and means for positioning the measurement photo detector at distance equal to the forward working distance of the scanning lens from the scanning lens on the reflected beam path.

8. A system according to claim 6 which further includes means for scanning the beams parallel to one another and to focus the beams on a flat plane at a predetermined distance; means for positioning a focusing lens in the reflected beam path at a distance equal to the focal length of the focusing lens from the object surface; and means for positioning the measurement photo detector at distance equal to the focal length of the focusing lens from the focusing lens on the reflected beam path.

9. A system according to claim 4 which further includes means for spatially filtering the beam using fiber optics including focusing the beam on to fiber optics and collimating the output beam from the fiber optics using a lens.

10. A system according to claim 9 which further includes means to produce a collimated beam in the range of few micro meter in diameter by using micro collimating lens.

11. A method of measuring the optical gap between two surfaces, one of which is transparent in accordance to claim 9 which further includes means for scanning beams parallel to one another by positioning the acousto optic deflector between two focusing lens such that, the distance between the two focusing lens is equal to the sum of their focal lengths, and the scanning area can be increased or

decreased by varying the focal length of the two focusing lenses and by positioning the acousto optic deflector closer to or away from the first focusing lens in the direction of the beam.

12. A system according claim 11 which further includes means for obtaining the reference signal from the zero order beam from the acousto optic deflector or by splitting the scanning beam using a non-polarizing bean splitter and directing the beam on to the bottom surface or surface of the object at an oblique angle such that both the S and P polarized beams get reflected from the bottom surface of the glass disk or from the surface of the object.

13. A system according to claim 12 which further includes means for detecting the optical gap between the bottom surface of the glass disk and the slider head by comparing the phase shift between the reference interference signal and measurement interference signal from the reference and measurement photo detectors respectively by heterodyne interferometric measurement; the displacement is calculated from the formula:

$$\Delta\phi = (\frac{2\pi}{\lambda})2h\cos\theta$$

where $h$ is the spacing between disk surface and ABS of slider, $\theta$ is the incident angle of the measurement beam, $\lambda$ is the wavelength of the laser beam, and $\Delta\phi$ is the phase change between the measurement and the reference signal.

14. A system according to claim 12 which further includes means for obtaining the pitch and roll angle at any time by directing three measurement beams on to the slider and the angle is measured by comparison of the independent measurement signal to the common reference signal.

15. A system according to claim 12 which further includes means for analyzing a smaller portion of the focused beam spot on the object; wherein the focused beam spot on the object can be measured by allowing only a certain portion of the interfered beam to strike the photo detector window using a diaphragm or slot before the photo detector.

16. A method for high speed and precision measurement of the distance between at least two near contact surfaces, one of which is an optically transparent element and the other is a substantially non-transparent element using heterodyne interferometry, comprising:

producing with a laser source,an output having two superimposed orthogonally polarized beams having S and P polarization, with a frequency difference between them;

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splitting the polarized beams into measurement and reference beams without altering the characteristics of the polarized beams;

means for causing the reference beams to interfere;

detecting with a reference photo detector the reference beams and providing a reference signal;

causing the measurement beam to strike the object of interest at an oblique angle after passing through a glass plate having a polarization coating on the bottom surface close to the object of interest, the oblique angle is such that the S polarization of the incident beam is reflected from the bottom surface of the polarization coated glass plate and the P polarization refracts through the glass plate, the P polarization reflects from the substantially non-transparent object of interest and refracts to the glass plate;

causing the reflected S and P polarization beams from the bottom surface of the glass plate and the surface of the object respectively to interfere;

detecting with a measurement photo detector the measurement beams and providing a measurement signal; and

determining the distance between the bottom surface of the glass disk and the object surface based on the phase deference between the measurement and reference signals from the measurement and reference photo detectors.

17. A method according to claim 1, wherein the laser source which produces two superimposed orthogonally polarized beams having a frequency difference between them includes a Zeeman laser source.

18. A method according to claim 16, wherein the laser source which produces two superimposed orthogonally polarized beams having a frequency difference between them includes an acousto optic modulator to produce two orthogonally polarized beams of a frequency difference equal to the center frequency or carrier frequency of the acoustic wave in the acousto optic modulator, and combining the orthogonally polarized beams from the acousto optic modulator having a frequency difference by using optical components.

19. A method according to claim 16 which further includes means for scanning the output of the laser source in both X and Y axes using an acousto optic deflector, wherein the two superimposed orthogonally polarized beams from the acoustic crystal of acoustic optic deflector at Bragg's angle which produces a first order scanning beam and a zero order beam, both containing the two orthogonally polarized beams.

20. A method according to claim 19 which further includes spatially filtering and expanding the laser output using a spatial filter including focusing optics and a pin hole depending on the beam expansion ratio and the quality of the required beam.

21. A method according to claim 19 which further includes focusing the scanning beam on a flat plane by using a lens.

22. A method according to claim 21 which further includes scanning beams parallel to one another and for focusing the beams on a flat plane at a predetermined distance, and positioning a scanning lens in the reflected beam path at a distance equal to the back working distance of the scanning lens from the object surface; and positioning the measurement photo detector at distance equal to the forward working distance of the scanning lens from the scanning lens on the reflected beam path.

23. A method according to claim 21 which further includes scanning the beams parallel to one another and to focus the beams on a flat plane at a predetermined distance; positioning a focusing lens in the reflected beam path at a distance equal to the focal length of the focusing lens from the object surface; and positioning the measurement photo detector at distance equal to the focal length of the focusing lens from the focusing lens on the reflected beam path.

24. A method according to claim 19 which further includes spatially filtering the beam using fiber optics including focusing the beam on to fiber optics and collimating the output beam from the fiber optics using a lens.

25. A method according to claim 24 which further includes means to produce a collimated beam in the range of few micro meter in diameter by using micro collimating lens.

26. A method of measuring the optical gap between two surfaces, one of which is transparent in accordance to claim 24 which further includes scanning beams parallel to one another by positioning the acousto optic deflector between two focusing lens such that, the distance between the two focusing lens is equal to the sum of their focal lengths, and the scanning area can be increased or decreased by varying the focal length of the two focusing lenses and by positioning the acousto optic deflector closer to or away from the first focusing lens in the direction of the beam.

27. A method according claim 26 which further includes obtaining the reference signal from the zero order beam from the acousto optic deflector or by splitting the scanning beam using a non-polarizing bean splitter and directing the beam on to the bottom surface or surface of the object at an oblique angle such that both the S and P polarized beams get reflected from the bottom surface of the glass disk or from the surface of the object.

28. A method according to claim 27 which further includes detecting the optical gap between the bottom surface of the glass disk and the slider head by comparing the phase shift between the reference interference signal and measurement interference signal from the reference and measurement photo detectors respectively by heterodyne interferometric measurement; the displacement is calculated from the formula:

$$\Delta\phi = (\frac{2\pi}{\lambda})2h\cos\theta$$

where $h$ is the spacing between disk surface and ABS of slider, $\theta$ is the incident angle of the measurement beam, $\lambda$ is the wavelength of the laser beam, and $\Delta\phi$ is the phase change between the measurement and the reference signal.

29. A method according to claim 27 which further includes obtaining the pitch and roll angle at any time by directing three measurement beams on to the slider and the angle is measured by comparison of the independent measurement signal to the common reference signal.

30. A method according to claim 27 which further includes analyzing a smaller portion of the focused beam spot on the object; wherein the focused beam spot on the object can be measured by allowing only a certain portion of the interfered beam to strike the photo detector window using a diaphragm or slot before the photo detector.